# UNHOLTZ-DICKIE CORPORATION

vibration generation systems and measurement instruments

Model 811M
RANGE-RESTORER
SN 130

MP MASTER
MA34557

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# MODEL 811 RANGE RESTORER

## 1.0 Principle of Operation

The Model 811 RANGE RESTORER consists basically of a gain changing network and impedance converter stage for the data signal path, and a dc level sensing circuit for the dc code signal as shown in the simplified block diagram of Figure 1 below:

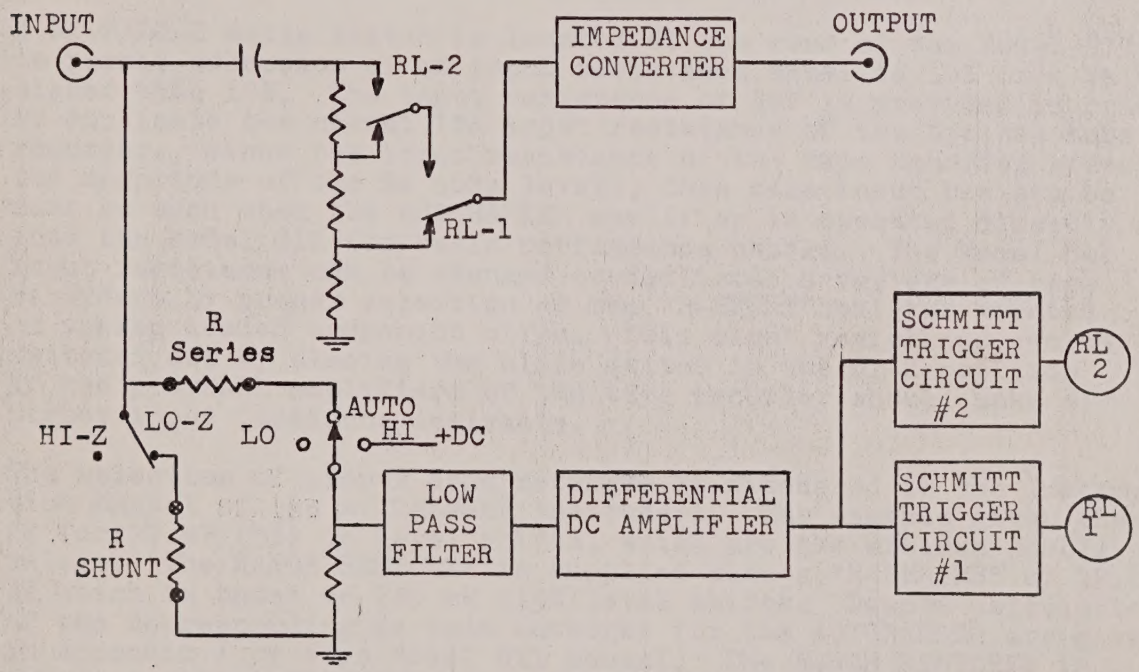


FIGURE 1.
MODEL 811 SIMPLIFIED BLOCK DIAGRAM

The input signal to the Model 811 is the dynamic data signal with a superimposed dc level shift. The magnitude of the dc level shift controls the gain state of the RANGE RESTORER. The low pass filter in the level sensing circuit rejects all signal frequencies above 20 Hz. The lower usable frequency of 20 Hz is selected to provide an acceptable compromise between rapid transient level-sensing speed of response vs range restoration for the frequency band in which the majority of resonant tests are performed. Operation below 20 Hz requires that the HI/AUTO/LO Switch be changed from the AUTO position to either the HI or LO position. The LO position selects the low gain (1/10) condition and the HI position selects the unity gain condition (equivalent to highest automatically selected range).

A typical recording level is with a 1 volt peak data signal level for full scale tape input and a dc level shift of 150 mV for each gain change command. This 15% level shift provides a compromise between occurance of false gain changes due to unexpected low frequency disturbances, and reductions in the data signal recording level required to avoid overmodulation or clipping in the recorder. The relative magnitude of the dc level shift to the data signal amplitude can be selected for the particular tape system to be used by proper selection of the "R-SERIES" attenuation resistor that is mounted on spring loaded component clips. The minimum dc level shift that can be used with the Model 811 RANGE RESTORER is 70 mV for each gain change.

A HI-Z/LO-Z slide switch is located at the rear of the Model 811 to permit selection of an input resistance equal to 10K or a value higher than 10K. The input resistance of 10K is provided in order to duplicate the normal 10K input resistance of the typical tape recorder. Since the input resistance of the tape recorder effects the magnitude of the dc code levels, this same input resistance must be used when the AUTORANGER amplifier is operated directly into the Model 811 for basic performance checks. The Model 811 input resistance can be changed to duplicate a variety of tape recorders by proper selection of the "R-SHUNT" resistor mounted on spring loaded component clips. This shunt resistance can be switched out by placing the slide switch in the HI-Z position if the playback amplifiers of the tape recorder should make a higher input impedance desirable.

The selection of proper code networks is discussed in the Instruction Manual of the AUTORANGER instrument. The example given there is for 70 mV (5%) dc level shifts, which are the minimum usable values. The RANGE RESTORER is supplied with a "R-SERIES" of 12.1K, 1% which is based on 150 mV (15%) level shifts. Sample calculations of the corresponding dc code networks for the AUTORANGER are given in Appendix I of this Model 811 manual. The RANGE RESTORER is supplied with a "R-SHUNT" of 17.8K, 1% to provide a LO-Z direct coupled input resistance of 10K nominal.

## 2.0 Operating Procedures

2.1 AUTORANGER Code Networks - Install the proper code networks in the AUTORANGER signal conditioning amplifier. Sample calculations are given in Appendix I of this Model 811 manual for code networks based on operation into a tape recorder direct-coupled input resistance of 10K and dc level shifts of 150 mV (15%).

If the tape recorder input resistance is greater than 10K, it can either be shunted to be made equal to 10K or the dc code resistor can be increased to provide the required dc shift. If the tape recorder input resistance is less than 10K, the dc code resistor must be decreased to provide the required dc shift.

If different values of dc level shift are required, the RANGE RESTORER "R-SERIES" attenuation resistor must be changed as shown in the sample calculation in Appendix II. A change in dc level shift also requires a change in both the code resistor and code capacitor of the AUTORANGER code networks as described in the sample calculation of Appendix I.

2.2 Instrument Interconnections - Recording and playback instrumentation system interconnections are shown in the simplified block diagram of Figure 2 below:

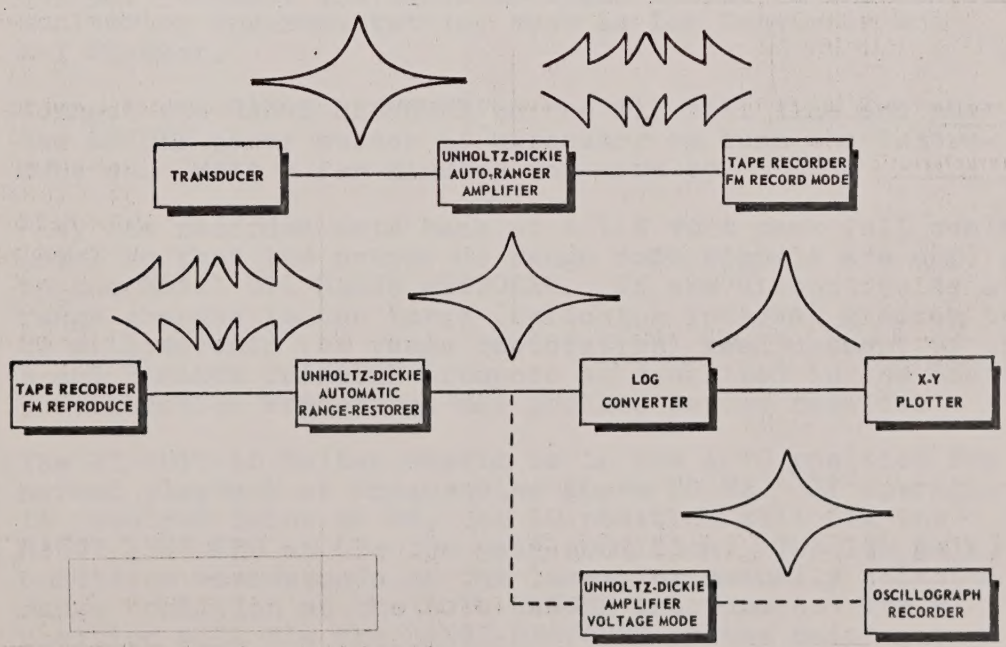


FIGURE 2
INSTRUMENT INTERCONNECTION BLOCK DIAGRAM

Note that a residual dc output of about 30 mV is produced by the AUTORANGER amplifier when operating on the lowest of the 3 applicable full scale ranges (the manually selected range). Since it is possible that the tape recorder FM reproduce amplifier has a different dc offset at its output, the Model 811 front panel LEVEL ADJ should be checked for proper setting as determined by the FM reproduce amplifier during playback; ie. the proper TP2 to TP1 bias voltage should apply when the AUTO-RANGER residual dc output has been played back. This proper TP2 to TP1 bias voltage is shown in Table 1 of the Section 3 Calibration Procedures.

2.3 With a full scale calibration signal applied to the AUTO-RANGER amplifier, normalize the TAPE output at 1.0 volt peak by adjusting the TAPE GAIN control as required. Use the MAN mode of operation to prevent range changing while full scale output is being checked.

2.4 With the AUTORANGER amplifier in the AUTO mode of operation, record the desired data on magnetic tape in the FM mode of operation. Note that the first range change should occur at a frequency above 20 Hz.

2.5 When the autoranged data has been recorded, connect the tape recorder playback output to the Model 811 RANGE RESTORER input BNC connector. Place the input impedance slide switch in the HI-Z or LO-Z position as may be required. Connect the RANGE RESTORER output to the desired monitoring instrumentation, such as Log Converter and X-Y Plotter.

2.6 Connect the RANGE RESTORER to the 115 volt line and push the ON/OFF power switch if necessary to turn the instrument on. Wait a few minutes for warm-up.

2.7 Play the recorded data back at a 1.0 volt peak full scale level so that the proper dc range code signals are applied to the Model 811 RANGE RESTORER. If the discontinuity at range changes is too large (switching interval greater than 20 milliseconds for range restoration) readjustment of the A and B RANGE TRANSFER trimpots as described in the Section 3 Calibration Procedures may produce better results.

2.8 The HI/AUTO/LO Switch should be in the AUTO position for normal playback at frequencies above 20 Hz. If operation is required below 20 Hz, the LO position will fix the RANGE RESTORER at the low gain condition. The low gain condition corresponds to the lowest or manually selected range condition at the AUTO-RANGER instrument. The HI position will fix the RANGE-RESTORER at the unity gain condition. This "high" gain condition corresponds to the highest or third range that can be automatically selected at the AUTO-RANGER instrument.

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## 3.0 CALIBRATION PROCEDURES (AUTO MODE)

3.1 Instrument Connections - The Model 811 RANGE RESTORER can be checked for proper operation by connecting the AUTORANGER tape output signal directly into the Model 811 input. The "R-SERIES" resistor supplied with the RANGE RESTORER is based on dc level shifts of 150 mV nominal. The "R-SHUNT" resistor supplied with the RANGE RESTORER is based on providing a 10K direct coupled input resistance when the Input Impedance slide switch is in the LO-Z position. For other values of "R-SERIES" and "R-SHUNT" refer to Appendix II.

The code networks used in the AUTORANGER amplifier should provide nominal 150 mV dc level shifts when operating into a 10K load. Refer to Appendix I for determination of the proper code networks.

It should be noted that the Model 811 test point bias voltages are different for the case of no input connected to the Model 811 and the case of the AUTORANGER connected to the Model 811 input but with no input signal connected to the AUTORANGER. This happens because there is a residual d-c output of 30 mV nominal from the AUTORANGER amplifier when it is on the manually selected full scale range (lowest of 3).

It should also be noted that the TP1 and TP3 test point voltages are both above ground potential, so floating or ungrounded dc measurement instruments must be used.

3.2 TP5 Relative to Chassis Ground - When the input to the Model 811 is disconnected, the voltage at the rear mounted TP5 test point should be *15.0* $\pm$ .3 volts dc with respect to ground. This voltage has been factory set and should not normally require adjustment. If, however, it should become necessary to reset this voltage, the balance of the Differential Amplifier should be checked. The Differential Amplifier Circuit Board is located next to the right side panel when viewed from the front. This side panel must be removed for measurement of the TP6 test point voltage and adjustment of the BALANCE pot. The voltage at the board mounted terminal, TP6, should be *15.0* $\pm$ .3 volts dc with respect to ground. If not, adjust the board mounted BALANCE pot for the proper voltage difference of *0.0* $\pm$ .2 volts dc and readjust the front panel LEVEL ADJ trimpot to obtain the proper levels. These levels are approximate levels and do not require critical adjustment.

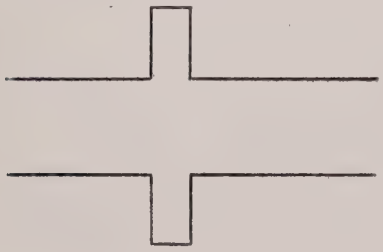
3.3 TP2 Relative to TP1 (Both are above ground) - This bias voltage determines the response of the RANGE RESTORER to the first AUTORANGER gain change and dc level shift. The bias voltages measured before and after the first range change are given in Table 1. Minor changes in the TP2

operating level can be made independent of the other test point voltages by adjusting the A TRANSFER ADJ pot.

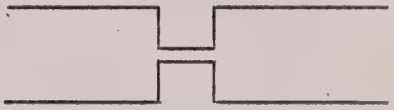
3.4 TP4 Relative to TP3 (Both are above ground) - This bias voltage determines the response of the RANGE RESTORER to the second AUTORANGER gain change and dc level shift. The bias voltages measured before and after the second range change are given in Table 1. Minor changes in the TP4 operating level can be made independent of the other test point voltages by adjusting the B TRANSFER ADJ pot.

3.5 Level Adjust - If the residual dc offset of the tape recorder FM reproduce amplifier does not equal the residual offset of the AUTORANGER amplifier, when it is played back. This can be compensated for by adjustment of the Model 811 LEVEL ADJ pot. The LEVEL ADJ pot changes the operating levels measured at TP2, TP4, TP5 and TP6.

3.6 Minimum Switching Transient - Range restoration by the Model 811 can normally be synchronized to within 20 milliseconds of the AUTORANGER gain changes. The output of the RANGE RESTORER will appear as either the A or B signal envelope shown below during the conditions of range transfer.



A Discontinuity



B Discontinuity

The B type discontinuity produces the least severe transient on an X-Y plotter when fed through a typical log converter. The most favorable setting of the A and B TRANSFER pots is achieved when the amount of discontinuity is minimized as range restoration takes place. When the AUTORANGER amplifier output is connected directly to the Model 811 RANGE RESTORER input, this characteristic can be observed on a scope by monitoring the Model 811 output as the range changes are restored for increasing and decreasing signal levels. The A and B TRANSFER ADJ pots can be rotated a few turns CW or CCW to determine the direction the minimizes the length of the switching discontinuity. The A and B TRANSFER ADJ pots are 25 turn pots. If either of these pots should get to full rotation, more adjustment range can be obtained by readjusting the LEVEL ADJ pot so that the required operating voltages of Table 1 can be ob-

tained with the A and B TRANSFER ADJ pots. In addition to the transient related to the synchronization of range restoration, there is a minor transient created by the dc code level change. This is minimized through the signal circuit path by the ac coupling time constants. The magnitude of this pulse is directly proportional to the amount of dc level shift used for the code signal. For a 150 mV dc level shift the RANGE RESTORER output pulse height is about 1db and decays out in about 0.5 seconds.

3.7 Nominal DC Operating Voltages - The dc voltages shown in Table 1 below should be measured with a sensitive, ungrounded dc voltmeter (such as Digitec Model ZR-212B or a good multimeter). These reference voltages are given for the case of an AUTORANGER amplifier tape output connected directly to the RANGE RESTORER input. The proper code networks must be installed in the AUTORANGER and the proper input resistors must be installed in the RANGE RESTORER. (Reference Appendix I and II). The AUTORANGER signal level must be on the full scale range indicated when checking the tabulated test point readings.

| AUTORANGER Output Level Condition | Model 811 DC Operating Levels | | |
|---|---|---|---|
| | TP 5 to Ground | TP 2 to TP 1 (not grounded) | TP 4 to TP 3 (not grounded) |
| Less than full scale on manually selected range | 14.7±.2 | 2.70 ± .2 | ——— |
| A range - 1st Automatically selected range | ——— | 0.75 ± .2 | 2.95 ± .2 |
| B range - 2nd Automatically selected range | ——— | ——— | 0.90 ± .2 |

TABLE 1.

## 4.0 DRAWINGS AND SPECIFICATIONS

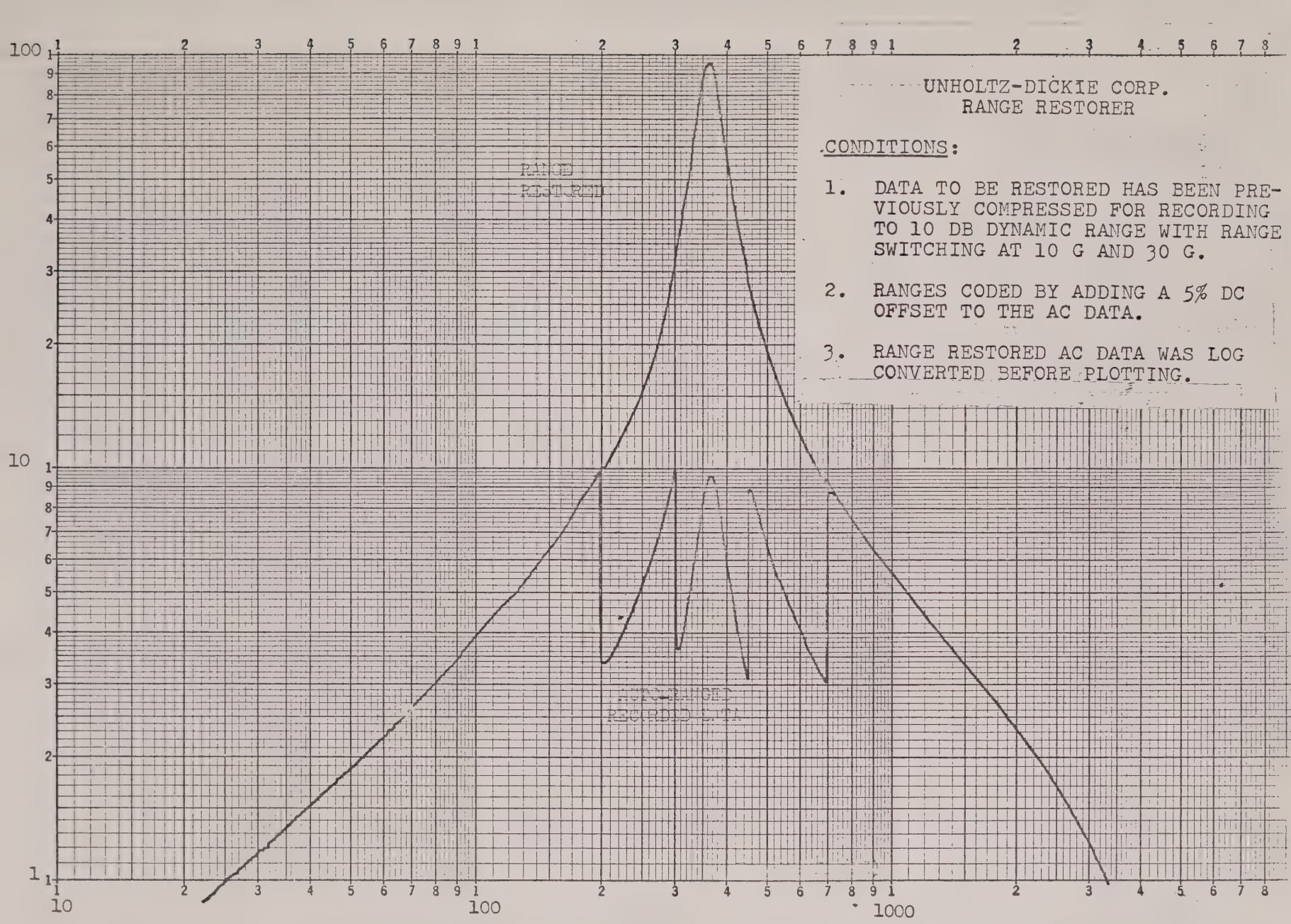
4.1 Circuit Schematic - C 5456

4.2 Specifications - Bulletin RR811-6-66

4.3 Publications -

4.3.1 Reprint from the Journal of Environmental Sciences titled "Performance Considerations for Automatic-Ranging Acceleration-Monitoring Equipment by Theron Usher, Jr.

4.3.2 Graph of X-Y recording of Model 811 output with a resonant input to an AUTORANGER amplifier.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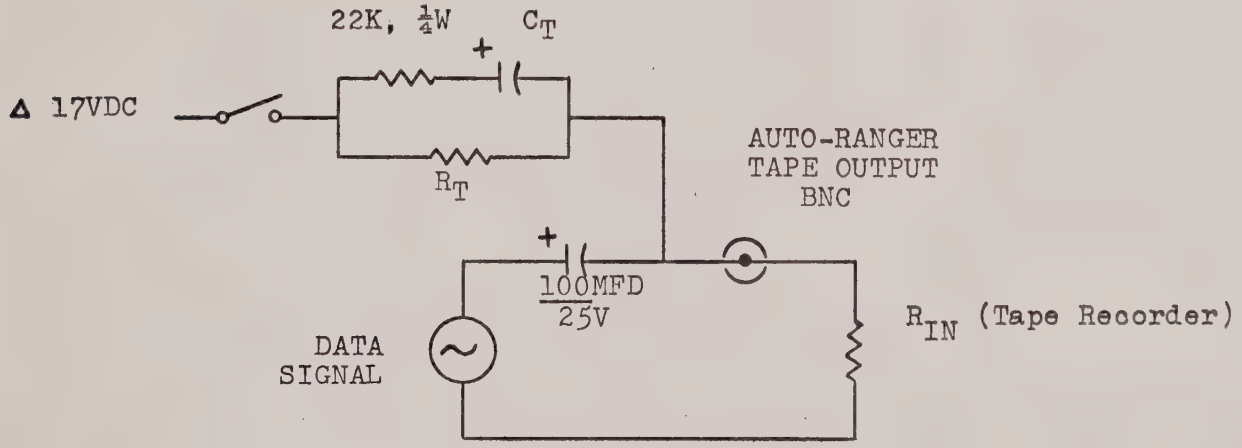
RANGE RESTORER
CONDITIONS:
1. DATA TO BE RESTORED HAS BEEN PREVIOUSLY COMPRESSED FOR RECORDING TO 10 DB DYNAMIC RANGE WITH RANGE SWITCHING AT 10 G AND 30 G.
2. RANGES CODED BY ADDING A 5% DC OFFSET TO THE AC DATA.
3. RANGE RESTORED AC DATA WAS LOG CONVERTED BEFORE PLOTTING.
100
10
1
10
100
1000
FREQUENCY (Hz)

## APPENDIX 1

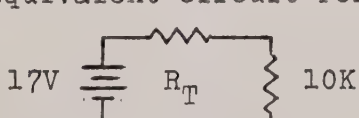
### Calculation of AUTORANGER Code Networks

The TAPE code networks are located on the AUTO-RANGER circuit board D at the top, center of the board. Code resistor, $R_T$, and code capacitor, $C_T$, are installed at the factory for playback with the Model 811 RANGE RESTORER, when recording with a tape recorder with a 10K direct coupled input resistance. The equivalent circuit relating to the calculation of the dc code networks is shown below:




The values of the code resistor $R_T$, and the code capacitor $C_T$ depend on the dc level shift required and the direct coupled input resistance of the tape recorder. The code networks are determined as follows for the case of a 150 mV dc level shift and a 10K tape recorder input resistance.

1. Equivalent circuit for $R_T$ Code resistor.

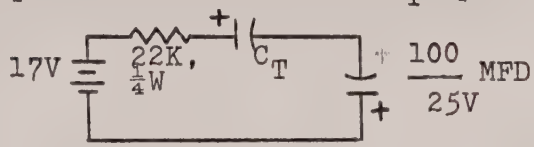



$$\frac{10K}{R_T + 10K} = \frac{.15}{17}, \qquad 170K = .15 R_T + 1.5K$$

$$R_T = \frac{168.5K}{.15} = 1.12 \text{ Meg}; \qquad \text{USE } \underline{1.0 \text{ Meg}, \tfrac{1}{4}W},$$

The same values are used for the A and B trip levels because the two dc voltages are added.

2. Equivalent circuit for $C_T$ speed-up capacitor.




$$\frac{C_T}{C_T+100} = \frac{.15}{17}, \qquad 17C_T = .15\,C_T + 15$$

$$C_T = \frac{15}{16.85} = .89; \text{ VALUES USED} - \frac{.33}{35V} + \frac{.33}{35V} + \frac{.1}{200V}$$

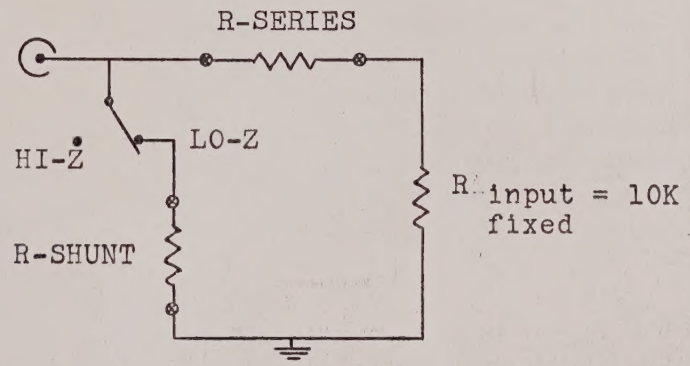
The subminiature capacitors are manufactured by Components, Inc. and are the Minitan Cordwood type B334 or equal.

Important: When a polarized speed-up capacitor is used, particular attention must be paid to be certain the capacitor is installed with the positive end oriented as shown in the circuit board D parts location drawing.

## APPENDIX II

### Calculation of RANGE RESTORER "Matching" Resistors

The level sensing circuit of The RANGE RESTORER is equipped with selectable "R-SERIES" and "R-SHUNT" resistors to match the instrument to the dc level shift desired and the tape recorder direct coupled input resistance for simulated operation directly from the AUTORANGER amplifier. The direct coupled input circuit of the AUTORANGER is basically as shown below:




When R-SERIES is a jumper (zero ohms), the RANGE RESTORER is designed to operate with 70 mV dc level shifts, and the HI-Z input resistance is nominally 10K. Operation with 150 mV dc level shifts is recommended to minimize false tripping from unwanted low frequency disturbances in the measured data. The matching resistors are calculated as follows for 150 mV dc level shifts and a LO-Z input resistance of 10K ohm.

1. R-SERIES

$$\frac{10K}{R_{se}+10K} = \frac{70\ mV}{150\ mV}$$

$$70R_{se} + 700K = 1500K$$

$$R_{se} = \frac{800K}{70} = 11.4K; \quad \text{USE } \underline{12.1K,\ 1\%}$$

2. R-SHUNT

$$\frac{(R_{su})\ (12.1K + 10K)}{R_{su} + 12.1K + 10K} = 10K$$

$$22.1K\ R_{su} = 10K\ R_{su} + 221K^2$$

$$R_{su} = \frac{221K^2}{12.1K} = 18.2K, \text{ USE } \underline{17.8K,\ 1\%}$$

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